Regional Simulation of Water Flow with alternative Land Use/Land Cover Data Sets

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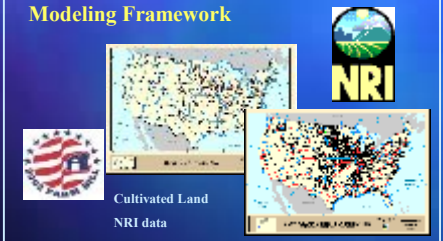
Introduction

Within the NRCS (Natural Resources Conservation Service) CEAP (Conservation Effects Assessment Project), the SWAT (Soil and Water Assessment Tool) (Arnold et al., 1998) model was applied to the Upper Mississippi river basin using alternative Land Use/Land Cover data sets. The Upper Mississippi River Basin drains 491,700 km2 in Illinois, Iowa, Missouri, Minnesota, and Wisconsin and outlets at the Mississippi River north of Cairo, Illinois. The Land Use/Land Cover data sets used in the study are the National Land Cover Dataset (NLCD)(Vogelmann et al., 2001) and the Global Land Cover Characteristics (GLCC) (Seepan, 1999). The first one is based on 1992 LANDSAT-Thematic Mapper (TM) data at 30-m resolution. The second one, at 1-km nominal spatial resolution, is based on the Advanced Very High Resolution Radiometer (AVHRR) developed in the same period. Founded on a previous assessment of the correlation of the two data sets and a GIS elaboration, this paper presents water flow simulation results and comparisons, and modeling insights using these data sets with SWAT at the regional scale.

The NRCS CEAP National Assessment Project

CEAP includes the use of models to quantify the environmental benefits of conservation practices at the national scale, termed a national assessment. A number of data sets, seamlessly covering the conterminous United States, have been developed and/or generated to feed the models. These include weather, landscape characteristics, and management practices. The models include the farm-scale model Agricultural Policy/Environmental Extender (APEX) (Williams et al., 2000) and the Soil and Water Assessment Tool (SWAT), along with a GIS representation of the landscape. APEX simulates conservation practices for cultivated cropland. Farmer surveys conducted on a subset of National Resource Inventory sample points provide information on current farming activities and conservation practices for APEX. Output from APEX will be input into the watershed scale model, SWAT, in the HUMUS (Hydrologic Unit Modeling for the United States) system for routing the pollutants to the 8-digit watershed outlet.

Modeling Framework



HUMUS Data Bases

- Land Use non cultivated (USGS-NLCD)
- Weather PCP and TMP
- Nitrogen Wet Atmosph. Deposition loading
- Point Source Records (USGS/USEPA)
- Management Data (AgCensus and USDA-NASS)
- Soil (NRCS-STATSGO)
- Topographic Data and Derivatives (from 3 arc seconds USGS DEMs)

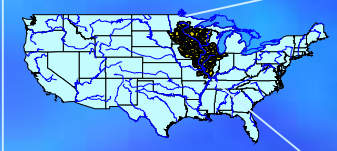
Cultivated Land NRI data (CEAP Farmers Survey)

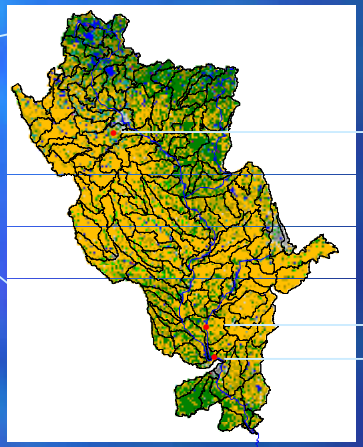
→ APEX

Watershed level Runoff, Sediment, N and P loading from Non-Cultivated Land, and Routing

→ SWAT

Upper Mississippi River Basin

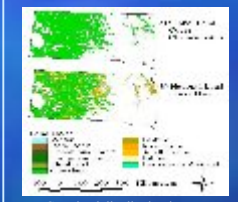




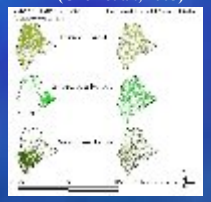
NLCD Coverage

- Open Water
- Low Intensity Residential
- High Intensity Residential
- Commercial/Industrial/Transportation
- Bare/Transitional
- Quarries/Strip Mines/ Gravel Pits
- Bare Rock/Sand
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrubland
- Orchard/Vineyards/Other
- Grassland/Herbaceous
- Pasture/Hay
- Row Crops
- Small Grains
- Urban/Recreational Grasses
- Woody Wetland
- Herbaceous Wetland

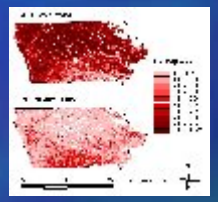
National Assessment NLCD vs.GLCC distribution (Chen et al., 2005)



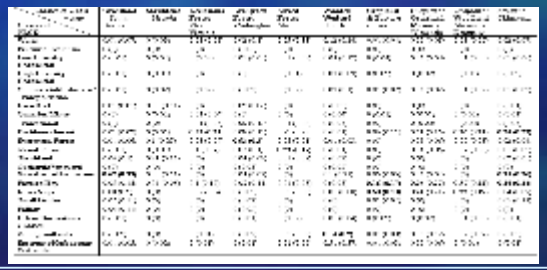
Grassland distribution in South Dakota



Forestland distribution for the state of Maine



Percentage of NLCD per 1-km unit in GLCC in Iowa.



Implementation of NLCD and GLCC

- NLCD and GLCC have been independently implemented within the CEAP-HUMUS framework.
- Ultimately, the implementations involved different land use derived parameter distributions.
- The preliminary results of the uncalibrated simulations (period 1990-2001) for three USGS stations in the Upper Mississippi River Basin are summarized in the table below

- R2 = coefficient of determination. E = Nash-Sutcliffe Model Efficiency

Station	Drainage Area (sq Km)	LU	Annual		Monthly	
			R2	E	R2	E
Minnesota River near Jordan, MN	43,715	NLCD	0.73	0.69	0.61	0.58
		GLCC	0.72	0.61	0.59	0.56
Illinois River at Valley City, IL	74,603	NLCD	0.70	0.59	0.68	0.52
		GLCC	0.71	0.63	0.68	0.51
Mississippi River at Grafton, IL	447,539	NLCD	0.61	0.55	0.52	0.50
		GLCC	0.63	0.56	0.53	0.49

Conclusions

The study presents preliminary results from a regional application of the CEAP National modeling framework in the Upper Mississippi River Basin with two distinct Land Use Land Cover data sets. NLCD was developed at the 30 m resolution and GLCC was developed at the 1Km nominal spatial resolution for the same period.

The statistics for 12 years of uncalibrated flow simulations are comparable. Further studies will be performed for the entire Basin and to assess the influence of sediment and nutrient loads.

References

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